Space Data for Crop Management

Potatoes are a high value specialty crop that can be more profitable to the farmer if he has advance knowledge of market conditions. If a grower has a good idea of the size and condition of his own and his competitors' crops, he can better make such important decisions as when to harvest and when to take his product to market; at the least, he knows his bargaining position.

Frank G. Lamb saw an opportunity for improving the financial yield of potato farming by providing accurate information on crop acreage and conditions on a more timely basis than the routine estimates of the U.S. Department of Agriculture (USDA)—namely, by processing and distributing data collected by the NASA-developed Landsat Earth Resources survey satellites.

Frank Lamb is a unique combination of crop grower and remote sensing technologist. He is president of the Eastern Oregon Farming Company (EOFC), Irrigon, Oregon, which has 10,000 acres of agricultural land in the Columbia River Basin planted in potatoes, alfalfa and wheat. His experience in remote sensing dates back to 1974, when he first employed aerial infrared photography for managing EOFC's irrigation system.

That experience led to an invitation to participate in the Large Area Crop Inventory Experiment, a 1977-79 joint NASA/USDA/National Oceanic and Atmospheric Administration program to measure crop yields worldwide by means of Landsat data. Later, Lamb served on a National Academy of Sciences committee studying application of remote sensing to agriculture.

His work on those projects sold Lamb on the idea that significant financial gains could be realized by interpreting Landsat data to get a close approximation of potato acreage and conditions. The drawback, in the 1970s, was that Landsat data processing required expensive mainframe computers and complex software whose cost would negate the advantages. But by 1983 advancing technology had made it possible to process Landsat data with a personal computer and less expensive related equipment, making the technology affordable to small businesses.

That year offered a graphic example of how timely knowledge of market conditions can pay off. At early harvest time of 1983, potatoes were selling at $80 a ton. Ninety days later the price was up to $130 a ton because of low potato yields and low quality. A farmer armed with advance knowledge of this underproduction could have delayed selling and realized an extra $50 a ton—and Frank Lamb had some 2,800 acres of potatoes on EOFC.

In 1984, Lamb decided to capitalize on this opportunity. With backing from other growers and a food processing company, he formed CROPIX, Inc., Hermiston, Oregon to monitor primarily potato crops in a 20,000 square mile area of northern Oregon and central Washington that produces more than a fourth of the U.S. potato crop. The company's initial management was Frank Lamb and his wife Birgitta; later they were joined by digital image analyst George Waddington, Jr. CROPIX' initial equipment, which involved an investment of $30,000, included an IBM personal computer, a color monitor, a tape drive and a color printer.

The primary data CROPIX uses originates in Landsats 4 and 5, now operated on a commercial basis by EOSAT, Lanham, Maryland. The Landsats' utility stems from the ability of sensitive on-board detectors to pick up reflectances emanating from Earth objects. Since each object has its own unique reflectance "signature," it is possible to distinguish among surface features; for example, Landsat data can be interpreted to tell the difference between one type of crop and another, or between diseased and healthy crops.

Landsat employs two types of Earth scanning systems, a multispectral scanner (MSS), which detects reflectance information in four bands of the spectrum, and a thematic mapper (TM), which collects data in seven bands. Relayed to Earth, the Landsat data can be computer processed to generate imagery identifying specific features of importance to resources managers,

Heading spinoffs in environment and resources management is a pioneering agribusiness that employs satellite remote sensing data to monitor crops

The upper photo shows a potato harvest at the Eastern Oregon Farming Company in the Columbia River Basin. A tractor pulls the harvester, which digs the potatoes, separates vines and rocks, and runs the potatoes up a conveyer belt into a truck. Above, company president Frank G. Lamb is hand-digging some of his potatoes to check their quality. Lamb is founder and operator of CROPIX, Inc., which employs satellite data to provide farmers and food processors timely information on potato acreage and crop health.

for instance, a large-area inventory of agricultural growths.

CROPIX buys computer tapes of Landsat data covering the irrigated 100-mile-wide Columbia River Basin and processes them to make acreage estimates of crops, particularly potatoes. In the early stages of a growing season, CROPIX is able to accurately map about 80 percent of the regional potato acreage by combining Landsat data with "ground truth," double-checking physical observation of selected crop fields. As the season progresses and Landsat supplies new data, the maps are updated and corrected. CROPIX also calculates a field-by-field vegetative index number, a numerical method for tracking and noting the vegetative health of a particular crop throughout the season.

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The end product CROPIX distributes to its customers is a booklet containing color-coded maps in various scales, essentially an inventory of the crops being grown in the Columbia River Basin, plus data and graphs on crop conditions and other information of value to the potato grower. CROPIX focuses on potato production because it is the Number One cash crop of the Basin area and involves the highest risk, thus the information is more valuable to farmers and potato food processors.

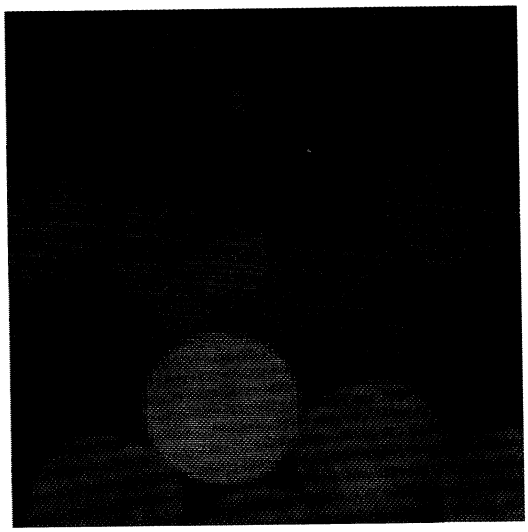
"If we can distill a couple of hundred megabytes of data into a few words," says Frank Lamb, "such as 'There are too many potatoes, the price is going down,' then CROPIX is performing a worthwhile service." CROPIX information, he says, enables potato growers to know better their bargaining positions when contracting with food processors.

Dissemination of space-acquired data to agribusinesses, through regional service organizations like CROPIX or directly to a farmer's or processor's receiving dish, offers great potential for the future. But improvements in the system are needed to take full advantage of the potential.

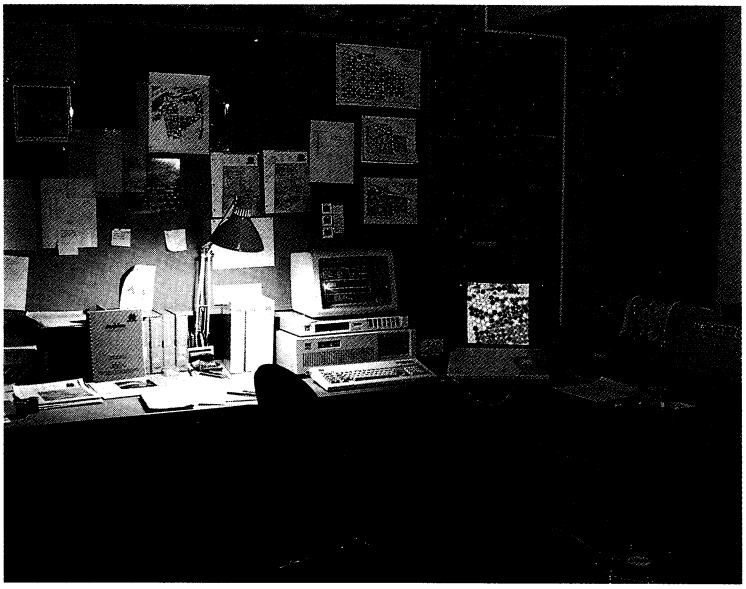
For example, image resolution, or the degree of detail the system can provide. Landsat has a resolution of 30 meters (about 100 feet), which means it can provide information on features of an area about one-fourth acre. Better resolution could enhance the efficiency of the system, but that will require relaxation of Department of Defense-imposed restrictions on space imagery resolution. The French SPOT system, which CROPIX has used to complement Landsat data, can provide detail of objects as small as 10 meters, but SPOT images cover overall areas only one-third as large as Landsat offers.

Perhaps the most significant improvement needed is time compression. Landsats 4 and 5 pass over a given point on Earth once every 16 days; once the data is relayed to Earth, it takes 10-14 days for delivery of the computer tapes. That, says Frank Lamb, is all right for the kind of regional surveys CROPIX is doing now, but it is not good enough to take advantage of one of

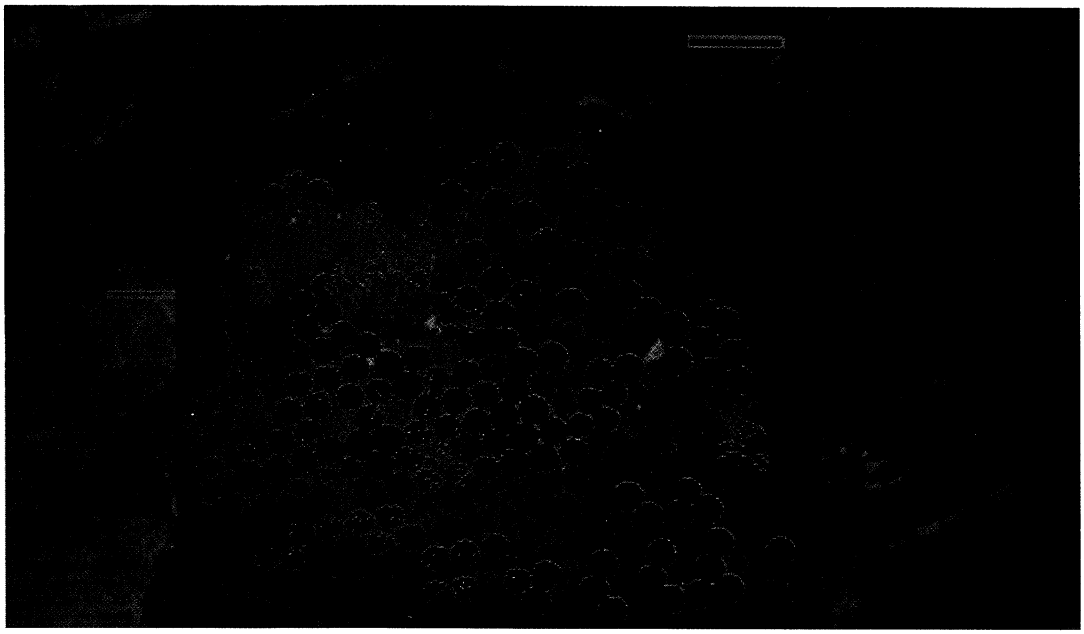
An Eastern Oregon Farming Company potato field.



This magnified view of a crop image shows (above) a dark wedge in one of the potato fields (red circles). The wedge represents an area of diseased or "stressed" crops. A major aim of ongoing research is to speed up data delivery to farmers so they can detect stress early and correct it before it causes significant crop losses.



The compact office of CROPIX, Inc. has all the equipment necessary to process computer tapes of satellite data and prepare regional crop inventory maps, such as the one shown below. This is a classification map based on Landsat satellite data. The red and pink fields are different varieties of potatoes; blue represents water, green is range land and the other colors indicate corn and wheat fields.



the prime potential benefits of remote sensing: detection of diseased crops early enough for the farmer to do something about it.

Says Lamb:

"If we could get remote sensing coverage once a week and data delivery in two to four days, we could detect stress in our fields. This frequency would be sufficient to allow us to go into our fields and correct the problem before it causes a reduction of yield."

CROPIX is playing a part in a NASA Earth Observations Commercial Application Program (EOCAP) designed to identify technological advances needed to expand the commercial benefits of remote sensing. CROPIX is teamed with Ames Research Center and Oregon State University, Corvallis, Oregon on a NASA-funded project to expand and refine the regional potato crop monitoring system, one of a number of EOCAP projects.

Ames' focus is on improvement of digital image processing techniques and field measurement support. OSU's Department of Agricultural Engineering is conducting field measurements and developing a regional potato yield model for use by CROPIX. Project scientists have made more than 20,000 ground truth measurements since 1988 to correlate actual crop acreage and conditions with the information acquired by satellite. This approach has allowed modification of forecasting techniques to the point where they are now 90-95 percent accurate. The Ames/OSU/CROPIX effort will be continued into 1991.